AQUATIC/WATER RESOURCES MANAGEMENT PLAN

Sequoia and Kings Canyon National Parks

January 1989

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SEQUOIA AND KINGS CANYON NATIONAL PARKS

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DESCRIPTION

OF

AQUATIC/WATER RESOURCES AND PROBLEMS

I. INTRODUCTION

Aquatic resources are well represented throughout Sequoia and Kings Canyon National Parks. There are about 2,650 lakes and ponds and thousands of kilometers of small rivers, mountain creeks, and intermittent streams. Other aquatic resources include cold-water springs and seeps, warm springs, soda springs, wet meadows, ephemeral pools, and an extensive winter snow-pack that occasionally lingers throughout the summer in small patches. Ground waters occur both in joints in the bedrock as well as in shallow, typically granitic soils. Some park caves contain underground streams, lakes, and small pools; many caves contain active speleothems which are formed secondarily as the result of aquatic processes.

Headwaters in a typical drainage originate between 2,700 and 3,700 m (8,900 - 12,100 ft), and begin either as small seeps and creeks or in cirque lakes. In many areas, water flows through wet meadows and small alpine lakes. From here, the small streams rapidly join to form larger streams and eventually rivers ranging up to 30-50 m (98 - 164 ft) wide. Drainage patterns are usually dendritic and typically flow west (except for the Kern drainage which flows south). Gradients are often steep.

The largely granitic basins have waters with low concentrations of charged constituents. Thus a high potential exists for water to be altered significantly by human activities. Being oligotrophic and poorly buffered, water is particularly susceptible to nutrient contamination (fecal waste, detergents, etc.) and acidic deposition.

Though vulnerable to human abuse, conversely, aquatic/water resources are one of the most hazardous resources that the visitor confronts. Nearly as many people die due to natural aquatic hazards than all other Park hazards combined (Powell, pers. comm.). Visitors seem to take precautions to protect themselves from snakebite and falling off cliffs, but water attracts visitors. They camp close to it, drink from it, swim in it, and fish in it; and when streams are high and the water is cold, the attraction to water causes some people to die in it. Water also can carry harmful disease agents (e.g. Giardia, Campylobacter, and Salmonella), and provide a home for disease bearing organisms to live such as mosquitoes which may carry encephalitis. In managing aquatic resources, not only must the

fragile aquatic systems be protected, but visitors must be informed of the potential hazards and how to avoid them.

This Plan identifies the goal and objectives, and actions for management of aquatic/water resources. To do this, the Plan presents an overview of the aquatic/water resources and lists known problems.

An Aquatic/Water Resources Management Program is presented that identifies the minimum standards at which the program should be implemented.

II. INFORMATION BASE

A. Present Status of Parks' Aquatic/Water Resources

Historically water in these Parks had been managed for human consumption and recreation. Maintaining natural aquatic systems was not a consideration, and as a result the aquatic resources are probably among the most altered resources in these Parks.

To this day, fish are one of the few park resources that can be harvested. Fish were planted extensively in barren waters throughout the Sierra Nevada (Christensen 1977). Not only were native species translocated to waters formerly barren of fish, but new species were also introduced (e.g. brook trout from the eastern United States and brown trout from Europe). In so doing, native Little Kern golden trout became threatened by genetic introgression, and today requires special management to protect its survival.

In addition to fish, other exotic organisms were also introduced (e.g. *Anacharis canadensis*). Some exotics were probably introduced by waterfowl, anglers, or as the result of fish planting (Taylor and Erman 1978), but some exotics were intentionally introduced to feed the introduced fish.

More recently, larger organisms were introduced. From 1949 to 1952, beaver were moved to sites south of Sequoia National Park in the Kern drainage (Townsend 1979). They quickly moved up into the park building dams, altering aquatic habitat, and changing structure of the streamside riparian vegetation.

Other water management activities were related to human consumption. Today there are water diversions for both public and private use.

As the park was developed, septic tanks proliferated. In the 1950's most old septic tanks were replaced by sewage treatment facilities, but many facilities were not adequate to handle the continuing increase in system demands and aging of the treatment facilities. At Giant Forest, Lodgepole, and Grant Grove, contaminated water leaked into streams.

Effluent monitoring at sewage treatment sites ensures compliance with State regulations and facility permit requirements. The requirements are designed primarily to ensure protection of public health and to avoid unacceptable degradation of surface and ground waters; they do not necessarily guarantee that the effluent from sprayfields will not alter local aquatic environments.

Some waters are captured within the park and used to generate electricity. A conduit with a capacity of about 90 CFS (Jordan/Avent & Associates 1980) transports water diverted from both the Marble and Middle Forks of Kaweah River to the Kaweah No. 3 power plant. Since 1964, permits specified that a minimum flow of 11 to 30 CFS depending on time of year) would not be diverted. Water has been diverted since 1913; and before the minimum flow requirement was instituted in 1964, operation of the power plant during periods of low flow removed most water and may have caused serious problems with the ecology of the river. Water is also diverted from the East Fork of the Kaweah River for similar purposes. Though diverted below the Parks' boundary, a series of dams was constructed in an upstream area that is currently part of Sequoia National Park. The dams were built to provide partial regulation of flow to the diversion.

B. Legal and Jurisdictional Issues

Though these Parks have exclusive jurisdiction over almost all of the land within its boundaries, all permitted water management facilities are regulated by the local Water Quality Control Board; and as required by the Clean Water Act (P.L. 95-217), our water management is to comply with State and local water quality standards. This is not to suggest that natural conditions that exceed State standards require mitigation, but it might limit use of such waters for public consumption or contact recreation. The Water Quality Control Board recognizes the value of maintaining pristine conditions.

Today, all portions of these Parks, except for the San Joaquin drainage, are located within the water quality management planning unit called the "Tulare Lake Basin". The unit is under the authority of the Cali-

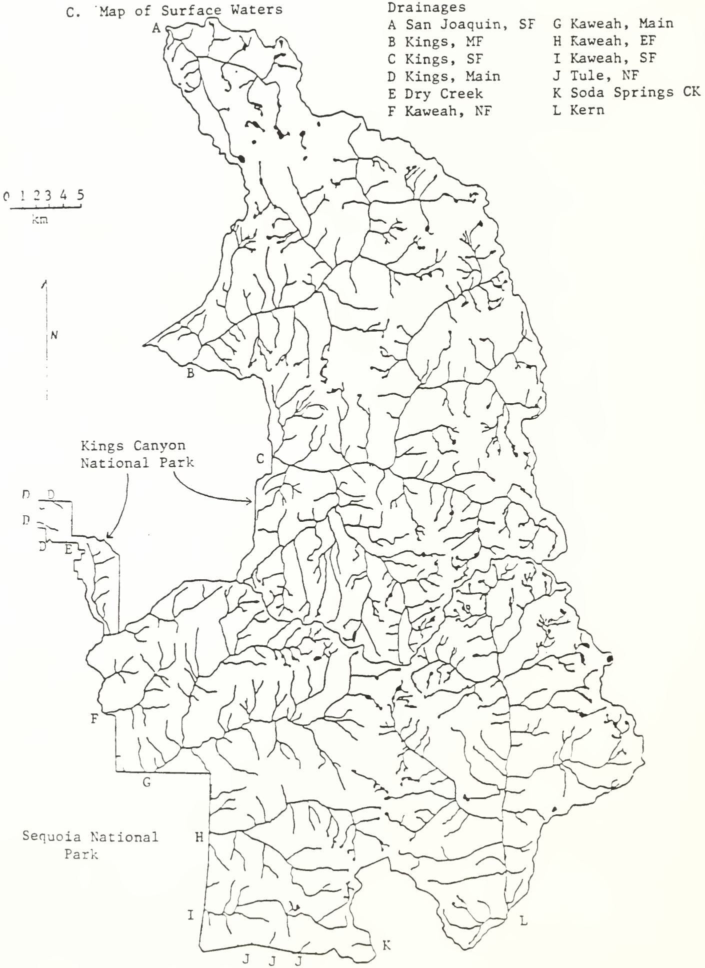
fornia Water Quality Control Board, Central Valley Region (5).

> The State Water Resources Control Board (SWRCB), operating under the authority of Division 1, Chapter 2 of the Water Code, various provisions of the Porter-Cologne Water Quality Control Act, and other provisions of the Water Code, coordinates statewide planning. In addition, the SWRCB exercises adjudicatory and regulatory functions of the State in the field of water resources, administers water rights, provides for consideration of water pollution and water quality, sets statewide water quality control policy and guidelines, conducts water quality research, and administers water quality aspects of the California Water Plan (from State Water Resources Control Board 1975).

Though we have historically been required to monitor permitted facilities, both research and routine monitoring of potential management impacts on aquatic resources is relatively recent. Water quality and limnological investigations have been done in several areas. Several lakes draining into headwaters of the South Fork of the Kings River were studied in the late 1970's (Erman 1977, Erman and Taylor 1978, Silverman and Erman 1979, Taylor and Erman 1979, Taylor and Erman 1980). Water chemistry of the East Fork of the Kaweah River was reported by several State and Federal agencies (Dean 1971, 1979; Federal Water Pollution Control Administration 1979; Troyer 1971, 1973). High lakes were surveyed for pH and trace elements in 1965 by Bradford, et al. (1968). This survey was repeated in 1980 - 1985. James (1975) studied human impacts on two lakes in the Kaweah drainage, and Hoffman and Ferreira (1976) examined effects of two fires in the Roaring River drainage on water quality.

Need for a parkwide water quality monitoring program resulted from P.L. 92-500 and a Memorandum of Understanding with EPA. A monitoring program was initiated and funded by the NPS, Western Regional Office in 1978. The U.S. Geological Survey in Menlo Park, California, developed the program in collaboration with the NPS. Portions were implemented annually during 1978, 1979, and 1980. This included a reconnaissance of major streams, and continuous measurement of water tempera-

C. Map of Surface Waters



ture, flow, and conductivity at those low-elevation streams. Monitoring by the Parks began in 1981, but only occurred during the summer. Initially, it was oriented toward providing baseline information for 20 long-term monitoring stations but expanded to include relating management practices and visitor use patterns to water quality impacts and public safety.

In 1982, a major inter-disciplinary program began investigating effects of atmospheric deposition on the Parks' natural resources. This study is providing a limnological investigation of three study areas: one located in an alpine area, another in a mid-elevation mixed conifer forest, and the third at a foothill chaparral site.

D. Classification of Surface Water by Existing Uses

Sites applicable to different types of use are identified below. The (p) or (s) in parentheses indicates primary (p) or secondary (s) use.

1. Public Water Supply

   a. Alder Creek (s)

   b. Atwell Mill (unnamed creek; s)

   c. Bearpaw (unnamed spring; s)

   d. Cascade Creek (s)

   e. Clover Creek Plant (s)

   f. Cold Springs (s)

   g. Copper Creek (s)

   h. Crystal Cave Parking Lot (unnamed creek; s)

   i. Dorst (unnamed creek; s)

   j. Hospital Rock (unnamed spring; s)

   k. Lost Grove (unnamed spring; s)

   l. Mineral King Pack Station (unnamed creek; s)

m. Paradise Creek (s)

n. Round Meadow (s)

o. Silliman Creek (s)

p. Silver City (s)

q. Sheep Creek (s)

r. South Fork Kaweah (s)

s. Tharp's Creek (s)

t. Wolverton Creek (s)

2. Non-public Water Supply

a. Cabin Creek (s)

b. Lewis Creek (s)

c. Lookout Point (unnamed spring; s)

d. Red Fir (unnamed creek; s)

e. Redwood Mountain Spring (s)

f. Silver City (unnamed creek; s)

3. Maintenance of Ecosystem, General

All aquatic resources of natural origin except as otherwise listed (p)

4. Maintenance of Ecosystem, Species of Special Interest other than Threatened and Endangered Species

a. Kern River (s) - for *Salmo aquabonita gilberti* (Kern trout)

b. Kaweah River (s) - for *Oroperla barbara* (a primitive stonefly), *Corydalus cognata* (a dobson fly), and undescribed *Denterophlebia sp.* (a mountain midge)

5. Maintenance of Ecosystem, Threatened and Endangered Species Indigenous to Parks

    a. Soda Springs Creek (p) - for *Salmo aquabonita whitei* (Little Kern golden trout)

    b. Coyote Creek (s) - for *Salmo aquabonita whitei*

6. Recreational Purposes, Contact

    a. All rivers, streams, and lakes except as otherwise noted and closed areas

    b. Kern Hot Springs (s)

    c. Snowpack (s)

7. Recreational Purposes, Non-contact

    a. All natural rivers, streams, and lakes except as otherwise noted and streams closed to fishing (s)

8. Agricultural, Source of Livestock Water Supply

    a. Creek above Ash Mountain rifle range (s)

    b. All rivers, streams, and lakes in areas not closed to stock (s)

9. Disposal of Sewage Effluent

    a. All park sewage ponds (p)

    b. All creeks, seeps, and ground water draining sewage sprayfields (s)

E. Floodplain Management

None of the Parks' floodplains have been identified or mapped. Some of the Parks' developments, particularly at Cedar Grove, Lodgepole, Mineral King, and Buckeye, could be within floodplain boundaries. A project statement (W-4) has been submitted addressing the need for mapping floodplains.

F. Water Quantity

Most of the Parks' estimated 2,650 lakes and ponds are located at high elevations, above 2,700 m (8,900 ft). Though a few of the lakes exceed 30 ha (74 ac), most are only several hectares to less than a hectare in surface area. They vary in depth from 20 m (66 ft) to less than one meter (3 ft).

There are an estimated 2,453 km (1,524 miles) of mapped rivers and streams. There are probably several times as many kilometers of unmapped, primarily intermittent streams. The size of each drainage and total kilometers of mapped rivers and streams are listed in Table 1.

Two warm springs occur in the Kern drainage and three soda springs in the Kaweah drainage. All of these springs are small. Cold water springs and seeps are common throughout these Parks.

Wet meadows are common in both forested and alpine areas from 1,800 m to 3,600 m (5,900 - 11,800 ft). Wet meadows vary in size from less than one hectare to several hectares.

Though snow occasionally falls at all elevations within these Parks, the snowpack accumulates primarily at elevations above 1,500 m (4,900 ft). From mid-February to mid-March, the snow depth averages about 1-1/2 m (5 ft) at 2,400 m (7,900 ft) and 4 m (12 ft) deep at 3,200 m (10,500 ft) (Kraushaar, pers. com). Most of the snowpack forms during January through March; but at high elevations ($\approx$3,600 m), it may last into mid-July or early August. Early in the season, the snow moisture is about 30 percent, this increases to about 50 percent about May.

Table 1. Size of Drainages and Streams

Drainage	Area (ha)*	Mapped Stream Length (km)*	Estimated Discharge (l/sec.)*
South Fork, San Joaquin	16,816	107	1,000 - 4,000**
Middle Fork, Kings	63,066	384	1,400 - 4,000**
South Fork, Kings	100,172	758	1,700 - 82,000
Main Stem Tributaries, Kings	1,431	5	--
Dry Creek	164	1	--
North Fork, Kaweah	16,479	115	50 - 10,800
Main Stem, Kaweah	43,236	334	460 - 26,900
East Fork, Kaweah	20,412	128	300 - 11,600
South Fork, Kaweah	9,767	57	80 - 8,200
North Fork, Tulare River	1,389	6	--
Soda Springs Creek	1,216	4	--
Kern River	75,162	544	2,500 - 44,000
Total	349,310	2,453	

* ha x 2.47 = acres; km x 0.62 = miles; l/sec x 0.0353 = CFS

** Late summer only; spring flows for South Fork San Joaquin and Middle Fork Kings are probably in the range of 10,000 and 40,000 l/sec respectively.

G. Water Quality

The following is a generalized summary of available water quality values and State water quality objectives for all surface and ground water in the Tulare Basin. Water quality values are primarily from unpublished reports and records in the Parks' files. All values should be considered tentative until a comprehensive survey of aquatic/water resources is completed; however, these values are the best information available to date. A project statement (N-23) has been submitted for a complete inventory of aquatic/water resources.

Table 2. Summary of Water Quality Values

Constituent	Concentration: Boundary Sites	Concentration: Rivers-Streams	Concentration: Lakes	Concentration: Ground Water	NPS Minimum Standards State Water Quality Control Board Objectives — Maximum Allowable Levels: Surface	Maximum Allowable Levels: Ground
Physical Properties						
specific conductance (umhos/cm)						Annual Increase
Kings drainage	20-40	20-30	15-50	19-69	100	<4/yr
Kaweah drainage	20-140	1-120	5-20	245-566	175	<3/yr
Kern drainage	33	6-55	5-11	N.D.*	200	<5/yr
Tule drainage	9-19	9-19	9-19	N.D.	450	<6/yr
other drainages	1-30	1-30	N.D.	N.D.	N.S.**	N.S.
temperature (^{o}C)	5-20	0-20	0-22	16.5-21.5	<5^{o}F increase above mean	N.S.
turbidity (NTU)	0.24-28	0.10-126	0.27-2.2	N.D.	20% increase above mean	N.S.
Major Constituents						
calcium (mg/l)	1-18	0.8-31	0.3-3.0	3.8-66	N.S.	N.S.
magnesium (mg/l)	0-1.8	0-2.5	0.03-0.40	0.2-12	N.S.	N.S.
potassium (mg/l)	0.2-1.6	0.1-1.2	0.1-0.3	0.6-2.6	N.S.	N.S.

* N.D. = No Data ** N.S. = No Standard

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Constituent	Concentration: Boundary Sites	Concentration: Rivers-Streams	Concentration: Lakes	Concentration: Ground Water	NPS Minimum Standards State Water Quality Control Board Objectives — Maximum Allowable Levels: Surface	Maximum Allowable Levels: Ground
Major Constituents (cont'd)						
sodium (mg/l)	0.7-5	0.2-3.8	0.2-1.0	5.4-78	N.S.	N.S.
bicarbonate (mEq/l)	0.204-0.851	0.042-1.856	0.042-0.155	0.61-3.8	N.S.	N.S.
chloride (mg/l)	0.1-1.7	0.1-2	0.04-0.43	3.8-64	N.S.	N.S.
sulfate (mg/l)	1.3-6	0.8-8	0.2-0.8	0.8-15	N.S.	N.S.
Other Constituents						
Inorganic Nonmetallic						
ammonia (mg/l)	0-0.08	0-0.19	0.15-0.41	N.D.	25	N.S.
arsenic (mg/l)	N.D.	N.D.	N.D.	ND-0.077	0.1	same
barium (mg/l)	N.D.	N.D.	N.D.	N.D.	1.0	same
boron (ug/l)	0-20	0-10	N.D.	N.D.	N.S.	N.S.
carbonate (mEq/l)	0	0	0	0	N.S.	N.S.
cyanide (mg/l)	N.D.	N.D.	N.D.	N.D.	0.2	same
dissolved oxygen (mg/l)	7.6-12.6	7.4-12.7	5.8-9.6	N.D.	7-9 mg/l*	N.S.

* 9 mg/l in Kings drainage, 8 mg/l in Kern, 7 mg/l elsewhere

Table 2. Summary of Water Quality Values

	Concentration				NPS Minimum Standards State Water Quality Control Board Objectives	
					Maximum Allowable Levels	
Constituent	Boundary Sites	Rivers-Streams	Lakes	Ground Water	Surface	Ground
Other Constituents						
Inorganic Nonmetallic (cont'd)						
floride (mg/l)	0-0.1	0-0.2	N.D.	0.1-1.8	0.6-1.7*	same
nitrate-nitrite (ug/l)	0-53	0-133	0-115	<40-200	10,000	same
Orthophosphate (ug/l)	0-38	0-35	0-8	N.D.	N.S.	N.S.
pH	7.0-8.0	6.5-8.0	5.5-8.5	6.7-8.0	+0.3	N.S.
silica (mg/l)	3-20	2-24	5-6	N.D.	N.S.	N.S.
sulfide (as s;mg/l)	N.D.	N.D.	N.D.	N.D.	N.S.	N.S.
Metals						
cadmium (mg/l)	N.D.	N.D.	N.D.	0	0.01	same
chromium (mg/l)	N.D.	N.D.	N.D.	0-0.0003	0.05	same
copper (mg/l)	N.D.	N.D.	N.D.	0-0.0022	N.S.	N.S.
iron (ug/l)	10-80	0-30	5-27	0-0.36	N.S.	N.S.

* See SWRCB 1975

Table 2. Summary of Water Quality Values

Constituent	Concentration: Boundary Sites	Rivers-Streams	Lakes	Ground Water	NPS Minimum Standards State Water Quality Control Board Objectives: Maximum Allowable Levels: Surface	Ground
Other Constituents						
Metals (cont'd)						
lead (mg/l)	N.D.	N.D.	N.D.	<0.001-0.006	0.05	same
manganese (mg/l)	N.D.	N.D.	N.D.	0-0.02	N.S.	N.S.
mercury (mg/l)	N.D.	N.D.	N.D.	0-0.0001	0.0005	same
selenium (mg/l)	N.D.	N.D.	N.D.	0	0.01	same
silver (mg/l)	N.D.	N.D.	N.D.	0-0.0003	N.S.	N.S.
total hardness (mg/l as $CaCO_3$)	1-80	3-70	3-14	10-205	N.S.	N.S.
zinc (mg/l)	N.D.	N.D.	N.D.	0.01-0.64	N.S.	N.S.
Bacteria						
fecal coliform (per 100 ml)	0-170	0-415	0-1	N.D.	geometric mean 200 and 10% <400 for any 30 day period	2.2 for 7 day period

Table 2. Summary of Water Quality Values

Constituent	Concentration: Boundary Sites	Concentration: Rivers-Streams	Concentration: Lakes	Concentration: Ground Water	NPS Minimum Standards State Water Quality Control Board Objectives: Maximum Allowable Levels: Surface	NPS Minimum Standards State Water Quality Control Board Objectives: Maximum Allowable Levels: Ground
Bacteria (cont'd)						
fecal streptococcus (per 100 ml)	0-27	0-6600	0-150	N.D.	N.S.	N.S.
Biocides						
aldrin (mg/l)	N.D.	N.D.	N.D.	N.D.	0.017	same
chlordane (mg/l)	N.D.	N.D.	N.D.	N.D.	0.003	same
DDT (mg/l)	N.D.	N.D.	N.D.	N.D.	0.042	same
dieldrin (mg/l)	N.D.	N.D.	N.D.	N.D.	0.017	same
endrin (mg/l)	N.D.	N.D.	N.D.	0.0001	0.001	same
heptachlor (mg/l)	N.D.	N.D.	N.D.	N.D.	0.018	same
heptachlor epoxide (mg/l)	N.D.	N.D.	N.D.	N.D.	0.018	same
lindane (mg/l)	N.D.	N.D.	N.D.	0.00005	0.056	same
methoxychlor (mg/l)	N.D.	N.D.	N.D.	0.0002	1.0	same
organophosphorus & carbonate compounds (mg/l)	N.D.	N.D.	N.D.	N.D.	0.1	same

Table 2. Summary of Water Quality Values

	Concentration				NPS Minimum Standards State Water Quality Control Board Objectives	
					Maximum Allowable Levels	
Constituent	Boundary Sites	Rivers-Streams	Lakes	Ground Water	Surface	Ground
Biocides (cont'd)						
toxaphene (mg/l)	N.D.	N.D.	N.D.	0.001	0.005	same
2,4-D plus 2,4,5-T plus 2,4,5-TD (mg/l)	N.D.	N.D.	N.D.	0.0006	0.1	same
Radioactivity (pc/l)					200	same
gross beta (pc/l)	0-8.1	0-8.1	N.D.	N.D.	200	same
radium-226 (pc/l)	N.D.	N.D.	N.D.	N.D.	3	same
strontium-90 (pc/l)	N.D.	N.D.	N.D.	N.D.	10	same
gross alpha (pc/l)	0-3.5	0-4.2	N.D.	N.D.	N.S.	N.S.
Miscellaneous						
biostimulatory*	N.D.	N.D.	N.D.	N.D.	nuisance	N.S.
carbon-alcohol extract (mg/l)	N.D.	N.D.	N.D.	N.D.	3.0	same
carbon-chloroform extract (mg/l)	N.D.	N.D.	N.D.	N.D.	0.7	same

Table 2. Summary of Water Quality Values

Constituent	Concentration				NPS Minimum Standards State Water Quality Control Board Objectives	
	Boundary Sites	Rivers-Streams	Lakes	Ground Water	Maximum Allowable Levels Surface	Ground
Miscellaneous (cont'd)						
color	N.D.	N.D.	N.D.	N.D.	nuisance	N.S.
dissolved residue, 180°C	N.D.	N.D.	N.D.	242-298	N.S.	N.S.
foaming agent (mg/l)	N.D.	N.D.	N.D.	N.D.	0.5	same
floating material	N.D.	N.D.	N.D.	N.D.	nuisance	N.S.
oil and grease	N.D.	N.D.	N.D.	N.D.	nuisance/ visable film	N.S.
sediment	N.D.	N.D.	N.D.	N.D.	nuisance	N.S.
settleable material	N.D.	N.D.	N.D.	N.D.	nuisance	N.S.
suspended material	N.D.	N.D.	N.D.	N.D.	nuisance	N.S.
taste and odors	N.D.	N.D.	N.D.	N.D.	nuisance	same
toxicity	N.D.	N.D.	N.D.	N.D.	none	N.S.

H. Fisheries Management

Historically, the management of fisheries has been the management and history of fish planting. As stated previously, the first fish planting in the Sierra Nevada began in the 1850's and became widespread in the 1870's (Christensen 1977). The early planting was done by stock users, anglers, and anyone else interested in moving fish into waters barren of fish.

In 1912, the California Department of Fish and Game began developing plans for large-scale planting. The original concept was to select certain waters for planting and confine a single species to each. In 1916, they were planting lower elevation sites that were easily accessible by mule. In 1917, an egg collecting station was established at Rae Lakes for providing fish to the Mt. Whitney Hatchery.

In general, Loch Laven (brown trout) were planted at the lower elevations (4,000-7,000 ft), rainbow trout in the mid-Sierran elevations, and golden trout at the highest elevations. In later years, eastern brook trout were planted in the mid-Sierran elevations and cutthroat trout at the highest elevations. By the 1930's, only rainbow trout, eastern brook trout, and golden trout were being planted.

Because of the low productivity of these high-elevation oligotrophic waters, the initial proliferation of introduced fish slowed as the population increased and the lakes' productivity was unable to continue supporting large populations. Several documents from the period 1929-1935 show a concern for insufficient fish food, and in 1929 the Superintendent wanted to introduce organisms to supplement fish diets, though this attitude was reversed by 1935. This practice was implemented in Rae Lakes in 1919, prior to that area becoming a Park. That year, the Department of Fish Culture introduced both an amphipod (*Hyalella azteca*) and one alga (*Nitella* sp.) to Rae Lakes.

The first indication of exotic species being valued differently was in 1936. The Director stated that where exotics have proven high value, planting with exotics will continue. This implies that exotics would not be planted elsewhere. In 1938, David Madsen, who was

Supervisor of Fisheries for the National Park Service, criticized strongly the previous practices of introducing exotic species and mixing incompatible species. He believed that more than 95 percent of the important fish-producing waters of the United States were permanently injured. Policy was established to protect native species and preserve existing natural aquatic systems where they exist. Around 1941-42, the National Park Service began studying its barren waters. A letter from the Superintendent to the Director in 1942 asked that we be permitted to keep our barren waters barren of fish and to discontinue the planting of backcountry sites.

In 1938, fish rearing ponds were constructed near Buckeye Flats. They were constructed to raise trout from fry to fingerlings for planting elsewhere. During the first year, they raised 32,000 rainbow trout, though the Superintendent estimated that the facility could support 50,000 fish. In 1954, the ponds were still in service.

Ponds were recommended for construction at Lewis Creek but there are no records that they were ever built. However, quite a few streams were closed to fishing in 1945 for the purpose of providing fish to plant elsewhere. These included Yucca Creek, Cabin Creek, Granite Creek, Deer Creek (from footbridge on Sunset Village Trail to source), Marble Fork (between Generals Highway and Log Bridge), Silliman Creek (Generals Highway to source at Silliman Lake), Wolverton Creek (above Wolverton dam), Crescent Meadow Creek (above High Sierra Trail bridge), and the Kern River between the Chagoopa Bridge and Rock Creek.

In 1940, aircraft began to be used for fish planting. Formerly, pack strings were the principal means of transporting fish to backcountry sites. This increased efficiency and planting options.

Planting often involved several agencies. In 1941, an interagency agreement was developed for fisheries management that included the National Park Service, the U.S. Fish and Wildlife Service, and the California Department of Fish and Game. This would improve coordination and planning. Unfortunately, unplanned introductions by persons acting illegally on their own was still a problem at least as late as 1952.

In 1949, 500,000 fingerlings were planted in Park waters. This dwindled over the years, and there was a drastic reduction in 1955-56 from 171,901 fish to 85,000 fish. The following year, we decreased our planting of areas that we planted annually. Some lakes were planted only every three years due to a lack of food; some areas were planted on a five year rotation where they received only heavy fishing pressure.

In 1954, fisheries policy provided that annual crops of native and permanently established exotic species will be regulated. No exotics were to be introduced, but temporary exceptions would be made for areas of high angling value with the Director's approval. Alien species that were firmly established were to be managed similar to native species; and all publicity was to be factual.

In 1960, Wolverton Lake was set up for fishing by children (age 15 or younger). Gradually the pond silted in until it became non-existent. Today only the dam remains.

In 1961, a catch and release program was initiated in two streams: the Middle Fork from 0.2 km (1/8 mile) below Hospital Rock to Moro Creek and South Fork Kings River from Road's End to Bubbs Creek. The sites were called "fishing for fun" streams, and only one fish over 41 cm (16 in) could be kept; all other fish were returned to the stream. Anglers were restricted to artificial lures and single barbless hooks. The sites existed for at least five years, but the program received poor public acceptance, and most anglers fished elsewhere.

In 1975, National Park Service policy prohibited planting exotic fish and permitted planting only to reestablish native species. Waters that were originally barren were not to be planted with either native or alien species, but were to be permitted to remain in or revert to their natural state. This caused considerable controversy in California. As a result, planting has continued in seven lakes.

In 1979, these Parks imposed a three-fish limit on two streams: Middle Fork Kaweah from the boundary to Moro Creek and Marble Fork Kaweah from the water diversion to Silliman Creek; the latter was also limited to artificial flies and lures. These have continued to the

present. Additional restrictions have been imposed on portions of the South Fork Kings River and Tule River by State law; these are two-fish limits with different variations on terminal gear.

Implementation of the program to restore Little Kern golden trout to their original range and abundance began in 1979, though the planning and studies actually began about a decade earlier. This was an interagency project that includes the California Department of Fish and Game, Sequoia National Forest, Sequoia National Park, and the U.S. Fish and Wildlife Service. Little Kern golden trout became a threatened species because of genetic introgression from introduced rainbow trout. Two pure populations were in Sequoia National Park: headwaters of Soda Springs Creek and the Upper Coyote Creek drainage. The latter was an exotic population introduced from Rifle Creek around the turn of the century.

To restore the species, first hybrid rainbow-golden and alien brook trout were removed. Fish that could be moved for use by anglers were moved to untreated waters, the remaining fish were poisoned using either antimycin or rotenone. After the stream has had a chance to recover, pure Little Kern golden trout were moved into the barren stream to repopulate it. At first, this was done by moving adult fish, but collecting eggs from wild fish and planting fingerlings was the preferred technique in recent years.

I. Park Ecosystems

Sequoia and Kings Canyon National Parks are located between the San Joaquin Valley and the crest of the Sierra Nevada mountains. Elevations extend from 390 m (1,280 ft) at Ash Mountain to 4,418 m (14,494 ft) on top of Mt. Whitney, the highest point in the conterminous United States. The vegetation in the low elevations is primarily oak woodland and chaparral. The mid-elevations from about 1,500 - 3,300 m (4,900 - 10,800 ft) are dominated by a variety of coniferous forest communities, of which the best known are the groves of giant sequoia (*Sequoiadendron giganteum*). Alpine communities generally occur above 3,300 m (10,800 ft). Most of the Parks' lakes and ponds are located in the higher elevation conifer forests above 2,700 m (8,900 ft) and in alpine zones. Flowing waters occur at all elevations.

Most aquatic research within these Parks emphasized water chemistry. There have been few thorough limnological studies that describe flora, fauna, water chemistry, structure of the lake or stream, and how such functions interact. Most data that exists regarding water is of recent origin, and historic conditions are speculative. The most complete ecosystem studies are those in the Rae Lakes-Kearsarge Lakes-Sixty Lakes area (Taylor and Erman 1979, Silverman and Erman 1979) and current studies in progress on the effects of acid deposition.

Virtually all lakes in the Sierra Nevada originally were barren of fish life (Christensen 1977). Pleistocene glaciers excluded fish from the high Sierra. As glaciers retreated, rainbow trout moved upstream from lower elevations along the west side of the Sierra, and golden trout survived in the upper Kern River below the southern edge of the glaciers. However, in most areas the trout were separated from the high lakes by steep impassable canyon walls, waterfalls, and other natural barriers.

Because of the high elevation and lack of nutrients in the granitic basins, many lakes have relatively low productivity. Once planted, fish prospered on the initial abundance of food; but the productivity was too low to sustain them, and fish became stunted (Pister 1977). In other lakes, the growth rate came into equilibrium with food supply (Pister 1977). Lakes planted with exotic eastern brook trout are particularly prone to the first model. Some lakes cannot sustain a fish population except by periodic planting. This is usually due to inadequate spawning area but may also be related to low primary productivity. A survey of 137 lakes in these Parks showed that 61 percent were self-sustaining, 10 percent were probably reproducing, 12 percent had little or no reproduction, 4 percent were definitely not reproducing, and 13 percent were barren (Zardus et al. 1977).

In general, the lakes' flora and invertebrate fauna have barely been investigated. Studies in the Rae-Sixty-Kearsarge Lakes area found that those lakes with high visitor use to have extensive macrophyte growth and low nitrate concentrations. Lakes with low visitor use had

little to no macrophyte growth and high nitrate concentrations (Erman and Taylor 1978, Taylor and Erman 1979). Taylor and Erman (1979) hypothesized that micronutrients added by people caused the benthic flora to flourish, depleting the nitrate.

As with lakes, most high elevation streams were probably also barren of fish. Today, many of these creeks, as lakes are populated with eastern brook (Salvelinus fontinalis), rainbow (Salmo gairdnerii), golden (Salmo aquabonito), and hybrid rainbow-golden trout. Brown trout (Salmo trutta) begin to appear in the mid-elevations, and foothill rivers and streams consist primarily of rainbow and brown trout. The Sacramento sucker (Catostomus occidentalis) is common at low elevations. Other non-game species such as California roach (Hesperoleucus symmetricus) and riffle sculpin (Cottus gulosis) barely enter these Parks.

While investigating plankton in 41 lakes in the Sierra Nevada, Kubly (1983) found 129 algal taxa. Desmids (Chlorophyta) were the most diverse group, though diatoms (Bacillariophyta) and Dinobryon (Chrysophyta) were the most abundant. Diatoms present varied from forms having slightly acidic to slightly alkaline pH preferences.

Kubly (1983) found 52 zooplankton taxa of which only about half were typically limnetic; the remainder were typically benthic or littoral. Most abundant taxa were rotifers (19 taxa), cladocerans (14 taxa), and copepods (13 taxa). Within samples, the most frequently encountered species were Keratella testuda (a rotifer), Holopedium gibberum (a cladoceran), and nauplii of certain diatomid copepods.

Zooplankton densities varied from 1 to 388 individuals/liter, but were typically less than 50 individuals/liter. The number of species and abundance decreases with increasing altitude. With decreasing pH, the number of species decreased.

Over 100 invertebrate taxa have been identified in the Parks' streams. These are primarily aquatic insects. Abell (1977) reported five abundance-diversity groupings for aquatic invertebrates in these Parks. They include:

1. Type A (weak fauna) -- These are areas where both the density and diversity of invertebrates is low. Such sites occur on very small streams and some springs.

2. Type B (normal stream series) -- These streams have several common or abundant species. Density and diversity are normal with a positive diversity:density trend. These streams are usually small to moderately large.

3. Type B+ (streams with the most diverse fauna) -- These streams have a relatively high number of common and abundant species. Most of these are large streams with excellent riffle habitat; though some of the streams are of only moderate size.

4. Type C (typical unproductive streams) -- These streams have a normal species diversity but typically have only one common or abundant species. This condition is most likely to be observed in small streams and may be caused by a lack of riffle habitat (Abell 1977).

5. Type D (high density, low diversity streams) -- These are streams where there is little diversity but the dominant species are abundant. Abell (1977) referred to these as "punitive perturbed faunas". Wherever they were observed, some special conditions that could have altered the normal community structure were also observed. Type D communities were normally observed in larger streams.

Though there were density-diversity patterns, Abell (1977) did not find distinct associations of species. The most frequently encountered taxa were midges (Chironomidae), mayflies (Baetis and Paraleptophlebia), black flies (Simuliidae), and caddis flies (Micrasema and Hydropsyche).

A few of the aquatic fauna are of special interest. There are two rare invertebrates. One is a primitive stonefly (Oroperla barbara) that lives in mountain portions of the Kaweah drainage (Abell 1977, 1984); another is an isolated population of a dobson fly (Corydalus cognata) which is common in the eastern United States; and the other is a brown mountain midge

(Denterophlebia) that may be a new species and occurs from 200 to 2,135 m (660 - 7,000 ft) on the Kaweah River. One of the vertebrates, the Little Kern golden trout (Salmo aquabonita whitei), is the only aquatic species currently listed as "threatened" by the Federal government; none are listed as "endangered".

These Parks are participating in an interagency program to restore Little Kern golden trout to their original range. Their cousin, the Kern rainbow (Salmo aquabonita gilberti; Gall et al. 1981), probably occurs in the upper Kern. It is known to exist on the Kern River immediately below the Park's boundary, but its status within the Park is unknown. It too may require special protection for its future management, particularly against genetic introgression.

J. Water Rights

Water rights within Sequoia and Kings Canyon National Parks includes State appropriative water rights held by private parties and by the United States and the Federal reserved water rights of the United States. State appropriative water rights are held by the United States for domestic, recreational and fire protection purposes. The most notable non-federal water rights within the proclamation boundaries of the Parks are for Southern California Edison's diversions for hydroelectric power generation in the Kaweah drainage. Southern California Edison's claims to water in the Middle Fork and Marble Fork of the Kaweah River are made by virtue of notices of appropriation originally posted by the Mt. Whitney Power Company. Water appropriations such as these, made prior to 1914 by the posting of a notice, are vested rights. The specific characteristics of this type of water right, and of the Federal reserved water rights, are determined through State adjudication proceedings. Federal reserved water rights for Sequoia and Kings Canyon National Parks have not been quantified as of 1988.

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PART 2

AQUATIC/WATER RESOURCES MANAGEMENT PROGRAM

I. PARK-SPECIFIC OBJECTIVES FOR MANAGEMENT OF AQUATIC/WATER RESOURCES

A. Goal

To restore and/or maintain natural aquatic environments in which physical, chemical, and biotic processes function uninfluenced by human activities; and to inform all visitors and employees of aquatic hazards.

B. Objectives

1. To inventory and classify aquatic environments by physical and chemical characteristics and biotic communities present; identify both common and unique aquatic systems.

2. To maintain long-term monitoring stations in representative aquatic environments to record ambient conditions and to document changes and trends in physical and chemical characteristics and biotic communities; to be able to detect and distinguish between 24 hour, seasonal, and long-term shifts or cycles.

3. To locate and document the magnitude and direction of changes in aquatic environments which are caused by management activities or visitor use patterns; and to develop and implement management programs to mitigate those activities.

4. To detect and evaluate conditions and characteristics of external influences such as acid precipitation.

5. To recognize aquatic conditions that are potentially hazardous to human health and safety; to implement programs to advise visitors of health hazards and to take corrective action where the cause is not natural.

6. To monitor the quality of water entering and leaving these Parks with regard to compliance with local, State and Federal standards for surface water.

7. To comply with State and local water quality requirements at each of the Parks water and sewage systems.

8. To acquire sufficient knowledge about the water quality of these Parks to be able to provide intelligent input into State and local water management planning.

9. To monitor water chemistry within Little Kern golden trout habitat.

10. To develop fishing regulations and other management practices that favor survival and perpetuation of native species over exotic species.

11. To restore extant native species or genetically unique groups to their former range.

12. To allow waters incapable of sustaining fish populations through natural reproduction to become barren of fish.

13. To mitigate human influences affecting the natural densities and age-class distributions of native species.

14. To inventory distribution and abundance of all fish species at 10-year intervals.

15. To monitor the distribution of fishing effort and fisherman success.

16. To enforce and document fisherman compliance with regulations.

17. To monitor effect of existing management practices on fish populations.

18. To control and if possible eliminate exotic beaver and other exotic organisms.

C. Specific Problems Involving Management of Park Waters

1. Effects of Visitor Use/Management of Carrying Capacity

Wherever there is reasonable potential for people to impact the natural environment, there is a need to monitor impacts associated with existing levels of use and development models for predicting effects of changes in use levels. Unacceptable impacts not only include fundamental changes in the ecology of an area as occurs from human nutrient enrichment, but also includes generation of human health hazards (e.g. high bacteria counts caused by human fecal contamination) and protection of pristine vistas. Abrasion and denuding of the vegetation, formation of social trails (defined as trails that are not planned or maintained by the National Park Service), and the accumulation of litter and toilet paper are as unacceptable as fecal contamination, detergents, and other forms of anthropogenic deposition. In assessing the carrying capacity of an area, it is necessary to look at the chemistry and biota of a lake or stream, as well as the condition of the adjacent land. Is the brush trampled? Are there social trails? How many? Is there litter? Does it appear pristine or over used? In some areas, it may be possible to increase the carrying capacity by improving the habits of these who use an area.

In establishing biologic carrying capacities, it is necessary to know how much use an area receives, the impacts, and the relationship between use and impacts. Because of fundamental differences in stock and backpacker groups, it is important that these impacts be evaluated separately, and that in establishing carrying capacities, that the overall use and resilience of an area or habitat be considered.

Without the above information, management is in a poor position to manage the future ecologic integrity of our aquatic resources as the demand to use the Parks grows.

2. <u>Management of Park Facilities</u>

In developing a park, there is a constant danger of facilities themselves having an unacceptable impact. Every liter of water diverted from a stream would have been used "naturally" downstream. Removing 200,000 l/day (52,834 gal/day) from a stream whose discharge is 5,000 l/sec (176.5 CFS) will certainly cause more impact than from a stream that produces 500 l/sec (17.6 CFS). A sewage plant providing secondary treatment will have far less impact on a naturally high nutrient system than on low nutrient systems as are typical of the Sierra. Even small amounts of phosphate, nitrate, chloride, or other constituent added to the ecosystem from a sewage sprayfield contribute to anthropogenic change. Indirectly, the location of facilities affect human use patterns and thus the natural system.

As with carrying capacity, the question is "how much is too much?" As a park is developed, management has a basic responsibility to know how the development is impacting the natural aquatic environment. State and local requirements that are designed to protect human health and safety do not necessarily grant the same protection to the park's natural resources.

3. <u>Atmospheric Deposition</u>

Sequoia and Kings Canyon National Parks are located in a polluted airshed. Though some of the material carried aloft is natural, much of it is a result of human activities. Acidic wet deposition with a pH of 3.5 has been measured in Sequoia National Park (Lawson and Wendt 1982). High elevation lakes are poorly buffered and are extremely vulnerable to future acidification. Nature and extent of dry deposition is less well known. Baseline information on existing conditions is beginning to be collected in order to determine actual and potential effects.

The principal known source of local pollution are automobile emissions, oil fields, and various urban sources, particularly from the San Francisco bay

area. Because of the heavy use of agricultural chemicals in the San Joaquin Valley, they could also be present in the deposition. In spite of State air quality regulations, potential population, industrial, and agricultural increases may be posing an ever increasing threat to Park resources. In the future, these Parks may need to experiment with technologies such as liming (calcium carbonate used as a buffer) in order to mitigate high acidic levels resulting from atmospheric inputs to aquatic systems. However, we must first determine what are those impacts.

4. Management of Exotic Species

The history of aquatic resources management in the Sierra Nevada has led to profound changes in the ecology of much of the area, particularly in regard to the redistribution of native species and introduction of exotics. The problem is confounded by significant public support for the tradition of planting fish in the Sierra and also by the tradition of a consumptive fisheries harvest. Wise management of the Parks' fisheries should favor native species over exotic. Regulations need to provide for increased fishing harvest of exotic brown and eastern brook trout, while encouraging the restoration of natural populations of native rainbow and golden trout through increased "catch-and-release" fishing.

II. ANALYSIS OF ALTERNATIVES

This Plan is an extension of Sequoia and Kings Canyon National Parks' Natural Resources Management Plan (1976, and revisions that followed). The Environmental Assessment for that document included aquatic/water resources. The reader is referred to that document for an analysis of alternative management strategies. Because this document is an extension of the Natural Resources Management Plan and because it proposes no new controversial or significant impacts to the environment, a separate Environmental Assessment will not be prepared on this document.

III. MANAGEMENT ACTIONS

A. Monitoring

1. Long-term Monitoring

Long-term monitoring will be conducted wherever major rivers or streams ($\geq$ 300 l/sec; 10.6 CFS) cross the Parks' boundary and at sites representative of each of the significantly distinctive aquatic systems.

a. Boundary Sites

Monitoring at boundary sites will be conducted to evaluate compliance with State and local standards and to detect changes and trends in the water quality of the drainages those sites represent. Boundary stations will be monitored at five year intervals during spring maximum flow, during summer minimum flow, and following the first major fall storm. Constituents monitored will include temperature, flow, suspended material, turbidity, conductivity, alkalinity, dissolved oxygen, pH, ammonia, nitrate, orthophosphate, major constituents, chlorinated hydrocarbons, organophosphates, carbamates, chlorophenoxy herbicides, trace metals, radioactivity, fecal bacteria, and chlorophyll.

b. Distinctive Aquatic Systems

Monitoring of significantly distinctive aquatic systems will be done to detect long-term changes in the limnology of those systems. These stations will also be monitored at five year intervals, but only at one time of the year based on when (e.g. spring, summer, fall, winter) monitoring will be most meaningful based on previous limnological studies. These sites will be monitored primarily for changes in the structure and composition of their biotic communities. During the preliminary survey of these systems, certain taxa will be selected for long-term monitoring. The actual organisms and associated chemical and physical constituents will vary at each site depending on the

recommendations of those who originally surveyed the site. At 10-year intervals, sites will be measured for the same environmental constituents as at the boundary stations.

2. Environmental Impact Monitoring

This monitoring is directed at specific problems and may be of either long-term or short-term duration depending on the need. Likewise the nature of the problem will determine how frequently the site is monitored (e.g. weekly, monthly, several times a year, etc.).

a. Facilities

Sprayfield and other output from sewage facilities will be monitored for environmental impacts. At the minimum, this will consist of monitoring for downstream nutrient enrichment to determine the extent of effected area and will be conducted at least three times a year: during spring melt, during the peak of summer drought and following the first major fall storm. Other constituents may include fecal bacteria, chlorophyll, DO, chloride, PH, conductivity, and indicator organisms. Every five years additional samples will be collected at sites both upstream and downstream from the sewage facility and analysed additionally for major constituents, indicator organisms, and each of the constituents measured at boundary stations. A minimum of three samples will be collected above the input, directly below the input, and about a kilometer downstream (depending on rate of dilution). This will be done during the late summer.

Normally water diversions would not be monitored, but they may be where some question exists as to ecological impacts associated with the diversion. These will normally be short-term pulse studies that compare flows and biotic communities (particularly aquatic macroinvertebrates) above and below the diversion. Where the diversion is new, such as for a water supply to a new park development, baseline data

will be collected prior to construction. Ground water will be the preferred source of water supply to a new park development.

b. Visitor Use/Carrying Capacity

(1) Front Country

At least two front country areas that receive heavy visitor use will be monitored for associated environmental impacts. Monitoring will include impacts to vegetation (monitored by use of photo-points), litter and other shoreline impacts, nutrients, conductivity, fecal bacteria, and levels of visitor use. Physical, chemical, bacterial, and vegetation data will be collected a minimum of three times per year (spring, late summer, and following a fall storm), but chemical and bacterial data will be collected about 10 times during the course of the summer-fall. Visitor use data will be collected on at least 30 occasions by counting the number of people at the study sites between 1300 - 1400 hours on randomly selected days. Data will be stratified into weekends and weekdays. The sites will be described for major constituents at 10-year intervals.

(2) Backcountry

At least two backcountry areas with varying levels of visitor use will also be monitored to establish sensitivity and biological carrying capacity for either specific sites or generalized backcountry environments. This monitoring will be conducted at the beginning of the summer, late in the summer, and following an early fall front or late-summer shower causing surface runoff. Nearly the same data will be collected as at front country sites, but the visitor use data will be collected by a combination of registers and/or opportunistic counts by backcountry rangers.

At lake sites, data will also be collected on benthic macrophytes to include density, species composition, and evidence of physical trampling from swimmers and waders. Sites will be selected to distinguish between impacts typical of backpackers and stock parties.

c. Distribution and Abundance of Exotic Species

Distribution and abundance of identified exotic plants, invertebrates, and vertebrates will be monitored. In some cases, this will be accomplished as a by-product of other monitoring, such as fisheries monitoring discussed below. In other instances, separate or supplemental monitoring sites may be required. Such monitoring will be conducted at five-year intervals. The principal objective is to determine whether the species is expanding, declining, or reasonably stable.

d. Monitoring of Rare, Threatened, and Endangered Species

Such monitoring will be conducted annually for the distribution and abundance of Federally listed species. Currently this includes only one species, the Little Kern golden trout which will be monitored in cooperation with the California Department of Fish and Game. Each year an index of its population is devised by an empirical survey. The distribution and abundance of unlisted but rare species will be monitored opportunistically as a by-product of other studies and reports except where species may be safely and easily subjected to periodic reconnaissance.

e. Fisheries

The effects of various fishing regulations on fish populations will be monitored at five-year intervals in designated transects. Furthermore, data will also be collected on catch-rates, species caught, distribution of fishing effort, and fisherman compliance. The first

data base will be acquired using fish population transects. The next three data bases will be developed from creel census and the last from law enforcement encounters.

f. Environmental Trouble-Shooting

The Parks' aquatics and wildlife personnel will coordinate a response to monitor or investigate any observed or anticipated environmental aquatic problems within these Parks. Examples of potential problems include fish kills, hazardous waste leaks, sewage leaks, etc.

3. Monitoring for Health and Safety

a. Facility Compliance

All water, sewage, and other facilities regulated by State and local laws will be monitored as prescribed by regulations and the terms of each permit. Standards for National Park Service waters must not only consider human health and safety but also protection of natural ambient conditions. The Superintendent will be advised of problems regarding health and safety or compliance with requirements.

b. Ambient Health Threats

Health threats, regardless of source, will be monitored to determine those conditions most hazardous to humans. Examples would be the effects of rainfall or stock use on bacterial counts. Most bacterial counts will be derived as a by-product of monitoring discussed above (1 and 2). Special techniques, however, are required to test for the presence of *Giardia*. Minimum monitoring frequency is given in the minimum standards (Section IV).

B. Management

1. Visitor Management

One tool for managing water quality is to manage the number and distribution of Park users. Options

for managing use will include: no restrictions, restrictions on activities within specific areas (e.g. no camping, day use only), restrictions on number of people that can enter an area (e.g. trailhead or area quotas), or closure. Such actions may be imposed either to protect natural resources or to protect visitors from unsafe conditions. Closures and restrictions may only be imposed by the Superintendent; such actions may be taken whenever there is a known or suspected problem.

2. Visitor Safety Program

Water is the most hazardous natural resource in these Parks. Visitors will be warned of these hazards through signs and printed information. Major trails leading to fast cold water will be signed in English and Spanish to warn people of the danger. In addition to being warned of the danger of fast cold water, visitors will be advised of *Giardia*, bacterial hazards like *Campylobacter*, and recommended methods of treating water prior to consumption. Such information will be provided at visitor contact stations (visitor centers, ranger stations, museums, etc.), in the Parks' newspaper, and printed information will be included with backcountry use permits.

3. Facility Design

Facilities will be located and designed for minimum impact on the aquatic environment. As technologies improve, existing structures will be reevaluated for upgrade as a means of further reducing environmental degradation. Whenever existing facilities are found to be causing unacceptable impacts, funds will be sought to correct the problem. If necessary, the facility will be closed.

4. Fishing Regulations

Fishing regulations that favor native species over exotics will be developed and enforced with the long-term goal of restoring the natural distribution and abundance of native species.

5. Wet Meadows Management

See Stock Use and Meadow Management Plan.

6. Mitigate Effects of Acidic Deposition

If the problem of acidic deposition is shown to be escalating and lake and stream biota begin to change, experimental management technologies used elsewhere may be considered within these Parks on a small experimental scale (e.g. liming). The immediate and long-term threats and benefits of such actions will be carefully evaluated prior to any broadscale rehabilitation effort.

No secondary action to mitigate acidic deposition is as acceptable as eliminating the cause. Even if actions like liming did not themselves cause a fundamental change in the aquatic environment, the cost of such management could be prohibitive.

7. Public Education

Though there are often a few easily identified point sources of pollution such as a failing sewage system or an oil refinery dumping sulfur into the skies, much of the problem is less tangible such as the cumulative exhaust emissions of too many automobiles. Controlling such sources requires a broad base of public support for legislation that controls automobile emissions and other non-point problems. Providing the public solid information about sources and effects of pollutants on the Parks' resources is an important management tool.

8. Participation in Establishment of State and Local Water Quality Standards

The Parks' staff will take advantage of opportunities to participate in the revision or development of State and local water quality standards. Personnel will seek standards that are realistic and compatible with NPS objectives for the management of pristine conditions. Standards for NPS waters must not only consider human health and safety but also protection of ambient natural conditions.

C. Research

These Parks will maintain an active research program that can provide management solutions to aquatic resources management problems. Also needed is a thorough inventory and classification of the Parks' aquatic resources. This inventory will be used to select the most important sites for long-term monitoring; it will identify which aquatic environments are most vulnerable to various threats and where the most serious management problems already exist. Until a comprehensive study is funded, this information will continue to be acquired by the existing monitoring program and from other related studies.

IV. MINIMUM STANDARDS

At minimum standard, the aquatic/water resources program will retain the ability to detect and evaluate changes in aquatic systems resulting from management actions or visitor use. It will recognize water which is unsafe to drink and identify inconsistencies between ambient conditions an water quality standards.

Components	Standards	Responsibilities
Health	Areas that management suspects (based on heavy visitation) as being biologically unsafe to drink will be tested for fecal coliform and fecal streptococcus using a minimum of two replicates taken during late summer, spring melt, and when possible, one day after a rain, and the public using such areas will be advised of unhealthy conditions.	Resource Mgmt. (monitoring) Rangers (advise public of hazards) Mgmt. Assistant (media releases)
	Recognize environmental conditions that cause waters to be generally unhealthy for consumption in the high, mid, and low Sierra, and advise the public.	Resource Mgmt. (monitoring) Rangers (advise public) Safety (prepare brochures) Mgmt. Assistant (media releases)
	Sample all known warm and soda springs for heavy metals, toxic substances or concentrations, and bacteria; post areas that are not safe. Samples will be taken once during a high flow condition and again during a low flow condition using a minimum of two replicates.	Resource Mgmt. (monitoring) Rangers (post)

Components	Standards	Responsibilities
Park Management	Streams associated with Park facilities with any potential to pollute will be monitored at a minimum of one station both upstream and downstream of the site with a minimum sampling of once during the spring, late summer, and during or immediately following a major (≥ 3 cm; 1.2 in) fall storm. A minimum of two replicates will be sampled for fecal coliform, fecal streptococcus bacteria, and nutrients. Every five years additional sampling shall include major constituents and other constituents appropriate for the site (e.g. pesticides, heavy metals, etc.).	Resource Mgmt.
Visitor Use	Sample a minimum of one heavily used front country stream at one site upstream and one site downstream of the zone of heaviest use with a minimum sampling of once during spring, late summer, and during a major (≥ 3 cm; 1.2 in) fall storm using a minimum of two replicates and sampling for fecal coliform and fecal streptococcus bacteria, major constituents on a 10-year interval, physical qualities and chlorophyll.	Resource Mgmt.
	Sample as above a minimum of one lake heavily used by backpackers and a similar unused lake as a control.	Resource Mgmt.
	Sample as above a minimum of one lake heavily used by stock, a control lake, and one meadow-stream heavy-use site at an upstream and downstream location.	Resource Mgmt.

Components	Standards	Responsibilities
Standards	All major ($\geq$ 300 l/sec; 10.6 CFS) streams flowing either into or out of these Parks will be sampled at five-year intervals during the spring, late summer, and after the first major fall storm using a minimum of two replicates per site and sampling for all surface water standards in effect for the basin.	Resource Mgmt.
	All facilities will be monitored for compliance with State and local requirements.	Maintenance
Long-term Monitoring of Natural Systems	All natural aquatic systems need to be inventoried and classified on the basis of chemical composition, physical characteristics, and biota.	Research
	A minimum of one long-term monitoring station sampled at least once every five years needs to be established in each major type of aquatic system. Minimum monitoring to use same strategy as visitor-use component plus heavy metals and other trace constituents.	Resource Mgmt.

V. AQUATIC/WATER RESOURCES PROGRAMING SHEET- LIST OF CONTINUING AND PROPOSED PROJECTS- AQUATIC/WATER RESOURCES PROJECT STATEMENTS

See current revision of Natural Resources Management Plan for:

Proj. No.	Project Title	Proj. Type 1/
FUNDED		
RM-40	Water Quality Monitoring	Mon
RM-27	Fish and Wildlife Management	Mit
UNFUNDED		
N-27	Effects on Acid Rain on Vegetation and Aquatic Ecosystems	Res
RM-34 (RM-42)	Support for Water Quality Monitoring Program 2/	Mon
W-6	Measure Impact of People on Backcountry Lakes	Res/ Mon
N-25	Determine Ecological Impacts of Acid Precipitation on Selected Ecosystems	Res
N-23	Complete Inventory of Aquatic Resources	Res
RM-33	Aquatic/Fisheries Management	Mit
W-1	Study Impacts of Sewage on Mid-Sierran Streams	Mon
RM-11	Exotic Beaver Control	Mit/ Mon

Notes: 1/ Natural resources project types are:
Mit = Mitigation, Mon = Monitoring, Res = Research

2/ Part of RM-42 in Natural Resources Management Plan

Proj. No.	Project Title	Proj. Type [1/]
RM-50	Evaluate Environmental Effects Caused by Mineral King Dams	Res
RM-47	Monitor Effects of Kaweah No. 3 Water Diversion	Mon
W-4	Implement Flood Plain Studies in Developed Areas	Res

Notes: [1/] Natural resources project types are:
Mit = Mitigation, Mon = Monitoring, Res = Research

VI. REVIEW AND REVISION

All persons with responsibilities for management of aquatic/water resources will review this Plan annually. Proposed changes will be submitted to the Fish and Wildlife Biologist in writing. The Fish and Wildlife Biologist will compile changes and route them through the Chief of Resources Management for review and comments. If the Superintendent accepts the changes, they will be incorporated into the Plan and the revised Plan will be sent to the Regional Office for review and approval. Grammatical corrections and changes in the Appendix will be updated by the Fish and Wildlife Biologist as necessary. All revised pages will have the date of revisions typed in the lower right hand corner of the page. Revised pages will be sent to each Division, District, and Sub-district Office, the Western Regional Office, and other persons upon request.

VII. APPENDIX

A. Responsibilities

1. Superintendent

a. Responsible for the Aquatic/Water Resources Management program.

b. Approves/disapproves helicopter trips required to support the program.

2. Management Assistant

a. Prepares media releases.

3. Sanitarian

a. Coordinates monitoring of facility compliance with State and local requirements.

b. Investigates and evaluates potential health problems and seeks solutions.

c. Manages public health problems.

4. Maintenance Division

a. Operates facilities for sewage and water systems.

b. Monitors compliance with State and local facility requirements.

5. Safety Officer

a. Prepares and supplies brochures regarding health and safety threats regarding aquatic resources.

b. Reviews and monitors lab safety.

c. Oversees Hazard Waste program.

6. Ranger Division

   a. Enforces fishing regulations.

   b. Helps prepare Special Regulations for the CFR.

   c. Advises backpackers and other visitors of health and safety problems and the appropriate way to prepare water for drinking in the back-country.

   d. Enforces closures and restrictions.

7. Interpretive Division

   a. Provides public information on aquatic/water resources to include both safety and information about the aquatic resources.

8. Chief of Resources Management

   a. Oversees the Aquatic/Water Resources Management program.

9. Fish and Wildlife Biologist

   a. Manages the water quality monitoring program.

   b. Develops and reviews the Aquatic/Water Resources Management Plan.

   c. Manages Resources Management operations at the Research-Resources Management wet laboratory.

   d. Recommends changes to existing regulation regarding aquatic/water resources management.

10. Water Quality Technicians

    a. Implement aquatic resource monitoring programs.

11. Research Division

    a. Conducts aquatic resources inventories.

    b. Uses research to find solutions to aquatic/water resource management problems.